T-106.4200 Introduction to Compiling
Exam Dec. 16, 2009

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No written material is allowed in this exam. Submit at least one answer sheet, even if an empty one! Write on *each* answer sheet you submit the code of the course, the date, your name, and your student ID number.

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1. Answer shortly to the following questions:

   (a) What does the letter R stand for in LR(1)?

   (b) What is a lookahead symbol?

   (c) What is a token?

   (d) What is a static link?

   (e) What is predictive parsing?

(10 p)

2. Consider the following regular expression:

$$(a\,b\,c \mid (b\,a)^*)$$

   (a) Make an NFA for the regular expression by using *Thompson's construction.* Number states starting from zero.

   (b) Build a DFA from the NFA. Name the states by capital letters starting from A.

(6+6 p)

3. Transform the following grammar to a LL(1) grammar (if necessary, eliminate left recursion, and do left factoring):

$$E \rightarrow E[E] \mid E.\textbf{id} \mid \textbf{id} \mid \textbf{int}$$

   Give FIRST and FOLLOW sets for the new grammar. Construct a LL(1) parsing table. Is the grammar LL(1)? (12 p)

4. Consider the following grammar: $\{P \rightarrow P \Rightarrow P \mid P \texttt{ and } P \mid \texttt{not } P \mid (P) \mid \texttt{atom}\}$. Its LR parsing table is given below. Remove the parse conflicts by assuming that `and` is right associative, $\Rightarrow$ is non-associative, and the precedence of the operators (higher first) is `not`, $\Rightarrow$, and `and`.

	⇒	and	not	(	)	atom	$	P
0			s2	s3		s4		1
1	s5	s6					acc	
2			s2	s3		s4		7
3			s2	s3		s4		8
4	r5	r5			r5		r5	
5			s2	s3		s4		9
6			s2	s3		s4		10
7	r3/s5	r3/s6			r3		r3	
8	s5	s6			s11			
9	r1/s5	r1/s6			r1		r1	
10	r2/s5	r2/s6			r2		r2	
11	r4	r4			r4		r4	

(9 p)

P.T.O.

5. Transform the grammar of Problem 4 into an unambiguous grammar which satisfies the given associativity and precedence rules. (6 p)

6. Give an unambiguous grammar that is not SLR(1). (6 p)